

ISSN 1732-4254 quarterly

A geographical perspective on the Aral Sea crisis: three interpretations of an image

Kristopher D. White^{CDFPMR}

KIMEP University, 4 Abai Avenue, Almaty 050010 Republic of Kazakhstan; phone: +7727 270 42 87, fax: +7727 270 43 44; e-mail: kwhite@kimep.kz

White, K.D., 2013: A geographical perspective on the Aral Sea crisis: three interpretations of an image. In: Szymańska, D. and Chodkowska-Miszczuk, J. editors, *Bulletin of Geography. Socio-economic Series*, No. 21, Toruń: Nicolaus Copernicus University Press, pp. 125–132. DOI: <http://dx.doi.org/10.2478/bog-2013-0026>

Abstract. The Aral Sea crisis has gained global notoriety as a human-induced environmental disaster. This paper contextualizes this crisis within a broad geographical framework. Three interpretations of a single photographic image emblematic of the desiccation of the Aral Sea are related to general foci within the academic discipline of geography. These interpretations serve to guide a framing of the Aral Sea crisis within a geographical context. This is presented as a geographical problem, incorporating elements and processes salient to physical geography, human geography, and human-environment interaction. With ecological and societal sustainability in the immediate Aral Sea region still a pressing concern, geographers are well positioned to contribute relevant, research-driven insights.

Article details:

Received: 31 October 2012

Revised: 08 March 2013

Accepted: 29 May 2013

Key words:

Aral Sea, geography, image interpretation, Central Asia.

© 2013 Nicolaus Copernicus University Press. All rights reserved.

Contents:

1. Introduction	126
2. Method for framing the Aral Sea crisis	126
2.1. Physical geography	127
2.2. Human geography	127
2.3. Human-environment tradition	127
3. The Aral Sea crisis in geographical perspective	128
3.1 Environmental crisis	128
3.2 Human crisis	129
3.3 Human-environment interaction	130
4. Conclusion	130
References	131

1. Introduction

The Aral Sea crisis has attracted substantial global attention over the course of the past three decades. A wide range of academic and popular press accounts have documented the death, decline, desiccation, and near-disappearance of what was once the world's fourth-largest inland water body (see e.g. Micklin, 1988; Ellis, 1990; Spoor, 1998; Glantz, 1999; Bissell, 2003; Micklin, 2010). Readers of this journal are undoubtedly familiar with the Aral Sea case, particularly that of an unparalleled anthropogenic environmental disaster, for good reason. Geographers recognize in the Aral Sea crisis a salience that resonates across our discipline's numerous subfields. Broadly speaking, physical geographers, human geographers, and geographers specializing in the interrelationships between human society and the 'natural' biophysical environment can each identify Aral Sea-related research questions appropriate to the respective subfields. The multi- and cross-disciplinary nature of geography would also seem to ideally position our discipline to address the complex, multi-scale coupled nature of the region's human and environmental systems in the continuing evolution of the Aral Sea crisis.

The relevance of the Aral Sea crisis to geography (and perhaps more importantly the relevance of ge-

ography to the Aral Sea crisis) provides an ideal opportunity for a reconciliation of the case and the discipline. In pursuit of this objective, the purpose of this paper is to frame the Aral Sea crisis within a broad conceptualization of the discipline of geography. Three interpretations of a single photograph, related to three broad foci of the discipline of geography, will facilitate this framing. In the process, historical and contemporary developments in the Aral Sea region will be described. This paper proceeds, following this introduction, with an image made by the author during a recent (September, 2011) expedition to the Northern Aral Sea in Kazakhstan. The image will be used first to extract and expand upon three broad approaches to geographical research. Three interpretations of this photograph will then guide a framing of the Aral Sea crisis within a geographical context. The paper concludes with a brief summary followed by a hopeful call for renewed interest, on the part of geographers, in the Aral Sea crisis.

2. Method for framing the Aral Sea crisis

A single image, made by the author on the former seabed of the Northern Aral Sea near Ak Basty, Kazakhstan in September of 2011 (Photo 1) will serve as a vehicle through which the geographical framing will be guided.



Photo 1. A desert-bound maritime vessel on the former Aral Sea bottom near Ak Basty, Kazakhstan

Source: Photo by author, 8 September 2011

While this image is unique (in the sense that no others exist from that precise location at that exact time), others like it, of rusting ships in the desert, are numerous and have come to symbolize the Aral Sea crisis. Three interpretations of this photograph, one of ecological destruction, a second of socio-economic decline, and a third of interrelationships between the ecological and social conditions coincide with three broad, general, and traditional foci within the discipline of geography.

2.1. Physical geography

One interpretation of the above image might focus on the physical, environmental elements displayed. Blue sky, interspersed with cumuliform cloud cover, extends to the horizon. In similar fashion, a barren and seemingly lifeless, flat, and arid terrestrial landscape expands as far as can be seen. The dominant element in the photograph is a human element, in this case a Soviet research vessel (the *Otto Schmidt*) which seems dramatically out of place. Of course what is glaringly absent is the depth and volume of water necessary to support such a vessel. We might surmise from this that some drastic environmental change has taken place here, and further suppose that a very large body of water has disappeared. In such a scenario, a body of water of this size would have also provided habitat for a variety of flora and fauna species, and served to moderate the local and regional climate.

The above narrative focused primarily on the presence or curious absence of natural environmental features (elements of the atmosphere, hydrosphere, lithosphere, and biosphere) of the landscape in the above photograph. Physical geography concerns itself with these environmental elements, in particular their distribution on the earth's surface, their development, and the various interrelationships between them (McKnight, Hess, 2003).

2.2. Human geography

Another interpretation of the above image might focus on the human elements portrayed. As mentioned above, the *Otto Schmidt* dominates the photograph, sitting isolated and abandoned to de-

cay. As the ship continues its wasting, rust and windblown sand are likely to rob it of its remaining identity – soon enough its name will no longer be visible. The human endeavor to which the *Otto Schmidt* was dedicated is no longer necessary or even possible. Soviet research funding and infrastructure have disappeared with the USSR's collapse. Other ships in similar photographs are of fishing vessels, emblematic of the once vibrant industry so vital for the region's economy and well-being of local inhabitants. Regardless of their original purpose, scientific research, cargo, transportation, or fishing vessels now decaying in the desert have also come to symbolize regional socio-economic decline. One other human element in the above image is a set of automobile tire tracks located off the port side of the *Otto Schmidt* stern. Something about this ship, and others like it, has attracted visitors. One is not accustomed to seeing maritime vessels stranded in the desert, of course, and the uniqueness of this scene and whatever dramatic events conspired to shape it may now have produced attractive destinations.

This narrative has concentrated on human elements in the above photograph, and has touched on a variety of activities (scientific research, transportation, industry, political process, tourism). Human geography can be viewed as the study of the locations and distributions of such human activity on the surface of our planet, and often seeks explanations for the resultant spatial patterns (Rubenstein, 2008).

2.3. Human-environment tradition

A third interpretation of the above image could concern itself with the correlation between the apparent dramatic environmental change and the decaying maritime vessel. Whatever happened to produce this scene has had clear impacts on both the physical environment and the lonely human element (the *Otto Schmidt*). The spatial and temporal correlation of the physical and human elements suggests that their declining fates are closely linked. This sentiment has been articulated vividly by William S. Ellis, who described similar landscapes on the former Aral seabed in Uzbekistan.

“Some of the vessels have been cut up for scrap, but several dozen remain, some with anchor chains played out across the sand and some gutted of all but the wasp nests in the wheelhouses. Cast in heavy coats of rust, all smell of the death of the sea and of themselves” (Ellis, 1990: 84).

The above description has stressed the interconnections between the bio-physical (death of the sea) and the human (death of the ships), another broadly-defined focus of the discipline of geography. In an influential and widely circulated article, William Pattison (1964) identified the ‘Man-Land’ theme as one of four defining principles of geography. The Human-Environment interrelationship approach has also been included as one of the ‘five unifying themes of geography’ (Joint Committee on Geographic Education, 1984) and conceptually informs the more recent emergence of research investigating the coupling of human and natural environmental systems (e.g. Liu et al., 2007; Werner, McNamara, 2007; Helldén, 2008).

3. The Aral Sea crisis in geographical perspective

A single image, presented above, generated three interpretations regarding the landscape presented. These interpretations, in turn, were related to three broad disciplinary foci within geography. Using this framework as an organizational guide, the Aral Sea crisis can be effectively presented in a geographical perspective.

3.1. Environmental crisis

With respect to the natural, biophysical environment, what has transpired in the immediate Aral Sea region can be classified as an environmental disaster. Over the course of the past five decades, the Aral Sea has shrunk dramatically (Fig. 1).

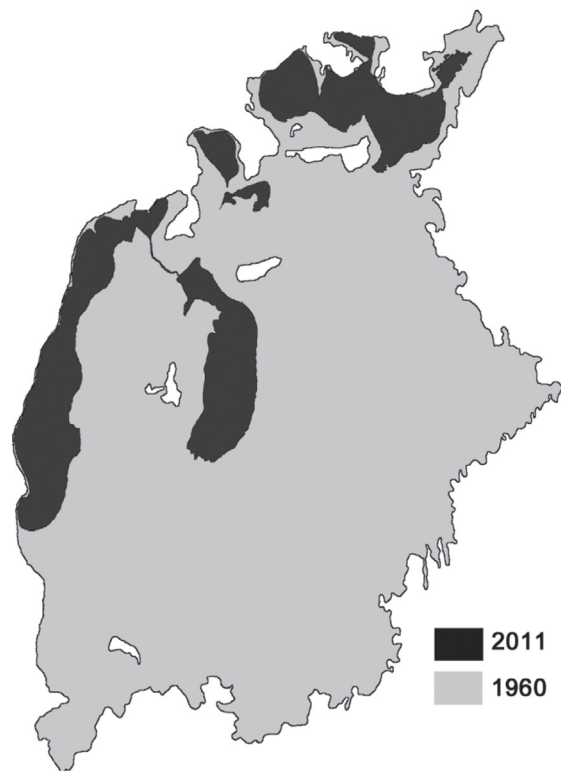


Fig. 1. Approximation of the extent of the Aral Sea in 1960 (lighter grey) and 2011 (darker grey)

Source: http://earthobservatory.nasa.gov/Features/World-OfChange/aral_sea.php?all=y, (Homepage of NASA Earth Observatory), DoA: 30 October 2012

The Aral's dramatic desiccation has formed, in the words of one expert, "one of the world's major environmental problem areas" (Spoor, 1998: 409). Others have called the crisis "one of the worst ecological disasters the world has seen" (Crighton et al., 2011: 125). In discussing global environmental change, Safford (2010) first cites the Aral Sea among important worldwide threats to sustainability. Situated in the arid border region between southwestern Kazakhstan and northwestern Uzbekistan, the Aral Sea is a terminal lake with no fluvial outflow. As such, its water balance is determined by the difference between inflow from the Syrdarya and Amudarya rivers and losses through net evaporation. Prior to 1960, this water balance was essentially in equilibrium, though since that time (Fig. 1) the Aral Sea has declined in surface area by 88 percent, water volume has declined by 92 percent, water level has dropped by 26 meters, and water salinity levels have risen by a factor of 20 in places (Micklin, 2010). Under such a scenario the debilitating impact on the Aral region's biodiversity stocks is not surprising. Habitat loss, both in the Aral and the delta regions of the Amudarya and Syrdarya, has decimated a variety of flora and fauna species. Escalating salinity has done the same for most of the Aral's fish species. In addition, dust storms carry salt-laden sediment from the former seabed across Eurasia. The Aral's climate moderation function seems to have also evaporated with its water. For instance, Small et al. (2001) document regionally warmer summers and cooler winters (by as much as 6 degrees C) since 1960.

3.2. Human crisis

Human populations living in the Aral's immediate region have also suffered disastrous consequences. Most of these impacts can be related to economic decline (including unemployment, poverty, loss of income opportunities) and to deteriorating health conditions. The former set of problems is most directly a function of the collapse of the Aral Sea fishery since the early 1960s. This fishery had become a vital source of income and employment for the communities around the Aral Sea, supporting a regional industry based on the harvest, processing, and export of fish. As the Aral receded, declining spawning habitat, increasing water salinity and ris-

ing contaminant concentrations contributed to the decline in the number and variety of fish. Not surprisingly, fish harvests in the Aral Sea also declined. In 1964, 41,120 tons of fish were harvested from the Aral. By 1974 this total had dropped to 15,500 tons, and by 1984 fish harvests on the Aral stood at zero (Kazakhstan Research Institute of Fisheries, 2011). Declining harvests proved disastrous for the fish processing centers of Aralsk, Kazakhstan and Moy-naq, Uzbekistan. Estimates place the number of job losses at 60,000 (Micklin, 1988). During the final decade of the USSR, processing facilities in these two locations kept operating at a minimal level by processing frozen fish imported by rail from as far away as the Pacific Ocean (Kumar, 2002).

Contemporary health conditions among residents of the immediate Aral region have been described as constituting a serious "public health tragedy" (Crighton et al., 2011: 125). Much of this tragic circumstance can be attributed to the Aral's desiccation and the resulting ecological crisis. The collapse of the fishing industry on the Aral Sea has also led to unemployment, poverty, and the removal of an important source of dietary protein. Another important factor has been the collapse of the Soviet health care system and infrastructure that has particularly impacted rural areas like those surrounding the Aral Sea. Specific contributors to poor health conditions span a broad array of factors. The general salinization and mineralization of the former Aral seabed occurred with the recession and evaporation of the lake. Salts and minerals have also made their way into the region from upstream areas in the Amudarya and Syrdarya basins. In addition, agricultural chemicals (fertilizers, herbicides, pesticides, and defoliants) applied to cotton fields (and other crops to a lesser extent) have also flowed downstream and have concentrated in the immediate Aral region. For those living around the former Aral Sea, these substances persist in the water they drink, the food they eat, and the air they breathe. Drinking water in Uzbekistan's portion of the Aral region (the autonomous republic of Karakalpakistan) has been found to have elevated biological and chemical contaminants as well as high salt and mineral content (Small et al., 2003). The food supply in this area has also been responsible for elevated dioxin intake (Muntean et al., 2003). Frequent dust storms transport pesticide-laden particles through the air and

into the lungs of residents (O'Hara et al., 2000). The heightened incidence of health problems and diseases within the Aral Sea region is striking. A partial list includes tuberculosis, anemia, and a number of forms of cancer, hepatitis, kidney malfunction, diarrheal disease, respiratory disease, hypertension, and heart disease (Small et al., 2001).

3.3. Human-environment interaction

As the above sections have shown, the Aral Sea crisis is indeed an environmental and socio-economic crisis. A full understanding of the genesis of these crises, their evolution over the past five decades, and most recent amelioration efforts does not emerge, however, without investigating interrelationships between humans (society) and the natural environment (nature) in the Aral basin. This investigation might begin by examining the first decades of the USSR and the Soviet drive to expand cotton production within the Aral Sea basin. The Soviets were not the first to grow cotton here, though the scale of 'success' of this endeavor was unprecedented and eventually proved unsustainable – most certainly for the Aral Sea and those living around it. As part of what Grigoryev (1952: 170) termed the "Stalin plan to remodel nature," expansive irrigation networks were constructed along the Amudarya and Syrdarya basins. One of these canals, what is today the Karakum Canal in Turkmenistan, is the world's longest irrigation ditch and is the single largest diverter of water meant for the Aral Sea. The volume of water diverted for irrigation, much of which was lost to percolation and evaporation throughout the irrigated portion of the basin, soon resulted in an ongoing recession of the Aral Sea (Fig. 1). Other impacts included rising water tables, and water logged, salinized, and mineralized soils. During the Soviet period, cotton fields were heavily fertilized and doused with liberal applications of herbicides, pesticides, and defoliants. As discussed earlier, these poisonous substances have concentrated near the Aral Sea and negatively impacted the health of human populations and of the ecosystem. If measured strictly with respect to cotton output, the Soviet efforts in this regard were certainly successful. Soviet cotton production more than doubled between 1960 (slightly above 4 million tons) and 1988 (nearly 9

million tons) (Pomfret, 2002). Today, Uzbekistan and Turkmenistan remain among global leaders in cotton production and export, and the sector is an important source of income and employment in Kazakhstan, Tajikistan, and Kyrgyzstan.

While the 20th century nearly saw the disappearance of the Aral Sea, the first decade of the 21st century witnessed human action aimed at partially restoring one portion of it. During the late 1980s, the receding Aral had split into two separate bodies, the smaller northern Aral Sea (NAS) in Kazakhstan, and the larger southern Aral mainly in Uzbekistan. In 2005, a dam and dyke complex (sponsored by the World Bank and the government of Kazakhstan) was completed along the southern edge of the NAS to the southwest of the Syrdarya delta. Additional construction of a spillway and rechanneling of the lower reaches of the Syrdarya, combined with water containment capabilities of the 200 meter-long Kok Aral Dam and eight-mile dyke, have led to an increase in water level, volume, and surface area for the NAS. Environmental conditions in and around the northern Aral have also greatly improved. Decreasing water salinity (today at roughly 1960 levels) has resulted in the return of a number of previously exiled (into more suitable fresh water of the Syrdarya) fish species (Micklin, 2010). The return of fish has meant the return of the fishing industry, though on a smaller scale than what existed during the pre-1970s Soviet period. Since the completion of the dam and dyke, commercial fish harvests have increased on the NAS, from 695 tons in 2005 to 3,520 tons in 2011 (Kazakhstan Research Institute of Fisheries, 2011). The rebirth of the fishing industry in the NAS has engendered among local residents a sense of hope and anticipation of more prosperous economic conditions. As one fisherman put it, while standing on the shore of the NAS near Tastobek, Kazakhstan in September of 2011, "Yesterday, fishermen arrived by motorcycle. Today they arrive by Uaz (*Soviet produced 4x4 vehicle*). Tomorrow they will arrive by sport utility vehicle."

4. Conclusion

A single image (Photo 1), not unlike others of a decaying maritime vessel stranded in a desert land-

scape once the Aral seabed, yielded interpretations focusing on environmental elements, human elements, and the spatial and temporal correlation between phenomena of nature and of society. As these interpretations relate to three broad foci of geography (physical geography, human geography, and human-environment interaction) this photograph facilitated a geographical framing of the Aral Sea crisis. The Aral case has been described here as an environmental crisis featuring a desiccating lake, desertification, destruction of habitat, and regional climate change. The environmental disaster is also a human crisis, with local populations plagued by the collapse of the Aral fishing industry and a multitude of health problems. The situation here is also a clear case of human-environment interrelationships and interaction, with a largely anthropogenic genesis and negative reciprocal feedback harming both the biophysical environment and human populations. Most recently, during the first decade of the 21st century, human modification in the form of dam, dyke, and rechanneling infrastructure, has resulted in both environmental and socio-economic improvements in and around the NASA. Heralding the return of the Aral Sea, as some popular press accounts have done, is wholly inaccurate. While one small portion of the former grandeur of the Aral has been stabilized, the southern Aral continues its desiccating retreat. Surrounding areas in Uzbekistan's autonomous republic of Karakalpakistan remain mired in conditions of ecological and socio-economic disaster. Under these conditions and given the recent success of restoration efforts on the NAS, could similar human intervention yield similar success in the southern Aral? Technically speaking, such a scenario is possible (see southern Aral stabilization plan in Micklin, 2010), though in practice unlikely. Amudarya river water is a necessary input for two of the world's leading cotton producers and exporters (Uzbekistan and Turkmenistan). Sharp reductions in water withdrawals along this river seem unlikely. In addition, if current oil and gas exploration efforts are successful in Karakalpakistan's former seabed, the already miniscule political will on the part of Uzbekistan to restore the southern Aral would most likely evaporate completely.

The Aral Sea crisis, as this paper has attempted to describe, is a geographical problem with opportunities for research across the broad spectrum

of geography. As most of the former Aral Sea region remains in ecological and socio-economic crisis, the urgency for global attention has not subsided. As the global community has reached a critical juncture with respect to environmental change, Stafford (2010) highlights the contemporary need for a broad interdisciplinary research approach bridging the gap between biophysical and human systems, in an effort to fully understand the interrelationships between those systems. The Aral Sea case is among the world's most pressing and dramatic instances of this interrelationship. Given the breadth and focus of our academic discipline, geographers are well positioned to be at the forefront of Aral Sea crisis research. This would appear also to be true for other similar anthropogenic environmental problems.

References

- Bissell, T.**, 2003: Chasing the Sea: lost among the ghosts of empire in Central Asia, New York: Pantheon Books.
- Crighton, E.J., Barwin, L., Small, E. and Upshur, R.**, 2011: What have we learned? A review of the literature on children's health and the environment in the Aral Sea area. In: *International Journal of Public Health*, Vol. 56, pp. 125–138. DOI: <http://dx.doi.org/10.1007/s00038-010-0201-0>
- Ellis, W.S.**, 1990: A soviet sea lies dying. In: *National Geographic*, Vol. 177, No. 2, pp. 73–92.
- Glantz, M.H.** editor, 1999: Creeping environmental problems in the Aral Sea basin, Cambridge: Cambridge University Press.
- Grigoryev, A.A.**, 1952: Soviet plans for irrigation and power: A geographical assessment. In: *The Geographical Journal*, Vol. 118, No. 2, pp. 168–179.
- Guidelines for Geographic Education: Elementary and Secondary Schools, 1984, Washington, DC: Association of American Geographers, Joint Committee on Geographic Education.
- Helldén, U.**, 2008: A coupled human-environment model for desertification simulation and impact studies. In: *Global and Planetary Change*, Vol. 64, No. 3–4, pp. 158–168. DOI: <http://dx.doi.org/10.1016/j.gloplacha.2008.09.004>

- Kumar, R.S.**, 2002: Aral Sea: environmental tragedy in Central Asia. In: *Economic and Political Weekly*, Vol. 37, No. 37, pp. 3797–3802.
- Liu, J., Dietz, T., Carpenter, S.R., Alberti, M., Folke, C., Moran, E., Pell, A.N., Deadman, P., Kratz, T., Lubchenco, J., Ostrom, E., Ouyang, Z., Provencher, W., Redman, C.L., Schneider, S.H. and Taylor, W.H.**, 2007: Complexity of coupled human and natural systems. In: *Science*, Vol. 317, No. 5844, pp. 1513–1516. DOI: <http://dx.doi.org/10.1126/science.1144004>
- McKnight, T.L. and Hess, D.**, 2002: *Physical Geography: A landscape appreciation*. Upper Saddle River, New Jersey: Prentice Hall, Inc.
- Micklin, P.**, 1988: Desiccation of the Aral Sea: A water management disaster in the Soviet Union. In: *Science*, Vol. 241, pp. 1170–1176. DOI: <http://dx.doi.org/10.1126/science.241.4870.1170>
- Micklin, P.**, 2010: The past, present, and future Aral Sea. In: *Lakes & Reservoirs Research and Management*, Vol. 15, pp. 193–213. DOI: <http://dx.doi.org/10.1111/j.1440-1770.2010.00437.x>
- Muntean, N., Jermini, M., Small, I., Falzon, D., Fürst, P., Migliorati, G., Scortichini, G., Forti, A.F., Anklam, E., von Holst, C., Niyazmatov, B., Bahkridinov, S., Aertgeerts, R., Bertolini, R., Tirado, C. and Kolb, A.**, 2003: Assessment of dietary exposure to some persistent organic pollutants in the Republic of Karakalpakistan of Uzbekistan. In: *Environmental Health Perspectives*, Vol. 111 no. 10, pp. 1306–1311.
- O'Hara, S.L., Wiggs, G.F.S., Mamedov, B., Davidson, G. and Hubbard, R.B.**, 2000: Exposure to airborne dust contaminated with pesticide in the Aral Sea region. In: *The Lancet*, Vol. 355, pp. 627–628. DOI: [http://dx.doi.org/10.1016/S0140-6736\(99\)04753-4](http://dx.doi.org/10.1016/S0140-6736(99)04753-4)
- Pattison, W.D.**, 1964: The four traditions of geography. In: *Journal of Geography*, Vol. 63, No. 5, pp. 211–216. DOI: <http://dx.doi.org/10.1080/00221346408985265>
- Pomfret, R.**, 2002: State-directed diffusion of technology: The mechanization of cotton harvesting in soviet Central Asia. In: *The Journal of Economic History*, Vol. 62, No. 1, pp. 170–188.
- Rubenstein, J.M.**, 2008: *The cultural landscape: An introduction to human geography*, Upper Saddle River, New Jersey: Prentice Hall, Inc.
- Small, E.E., Sloan, E.C. and Nychka, D.**, 2001: Changes in surface air temperature caused by desiccation of the Aral Sea. In: *Journal of Climate*, Vol. 14, No. 3, pp. 284–299. DOI: [http://dx.doi.org/10.1175/1520-0442\(2001\)014<0284:CISATC>2.0.CO;2](http://dx.doi.org/10.1175/1520-0442(2001)014<0284:CISATC>2.0.CO;2)
- Small, I., Falzon, D., van der Meer, J. and Ford, N.**, 2003: Safe water for the Aral Sea Area: Could it get any worse? In: *European Journal of Public Health*, Vol. 13, pp. 87–89.
- Small, I., van der Meer, J. and Upshur, R.E.G.**, 2001: Acting on an environmental health disaster: The case of the Aral Sea. In: *Environmental Health Perspectives*, Vol. 109, No. 6, pp. 547–549.
- Spoor, M.**, 1998: The Aral Sea basin crisis: Transition and environment in former soviet Central Asia. In: *Development and Change*, Vol. 29, pp. 409–435. DOI: <http://dx.doi.org/10.1111/1467-7660.00084>
- Stafford, S.G.**, 2010: Environmental science at the tipping point. In: *BioScience*, Vol. 60, No. 2, pp. 94–95. DOI: <http://dx.doi.org/10.1525/bio.2010.60.2.2>
- Unpublished yearly fish harvest data for the Aral Sea (1961–1984) and the Northern Aral Sea (2005–2011), 2011, Aralisk: Kazakhstan Research Institute of Fisheries.
- Werner, B.T. and McNamara, D.E.**, 2007: Dynamics of coupled human-landscape systems. In: *Geomorphology*, Vol. 91, No. 3–4, pp. 393–407. DOI: <http://dx.doi.org/10.1016/j.geomorph.2007.04.020>
- http://earthobservatory.nasa.gov/Features/World-OfChange/aral_sea.php?all=y, (Homepage of NASA Earth Observatory: Shrinking Aral Sea, World of Change, Satellite Image from 15 August 2011), DoA: 30 October 2012.

